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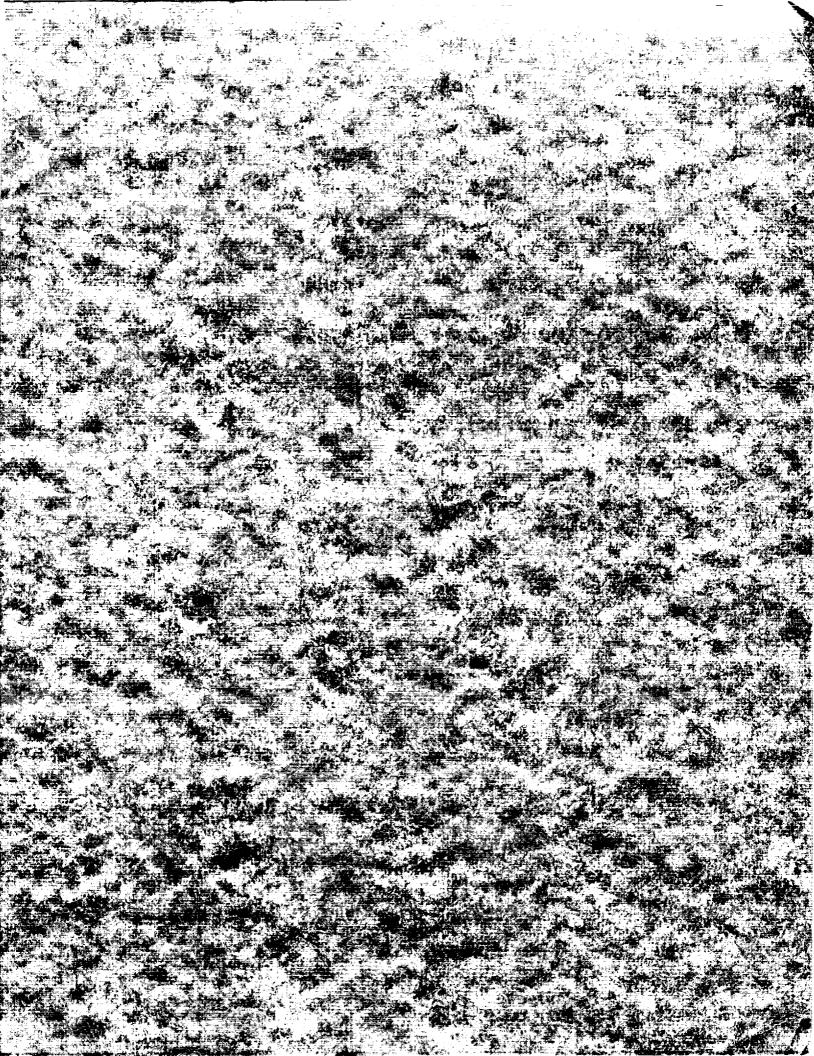
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# LINEARLY TAPERED SLOT ANTENNA IMPEDANCE CHARACTERISTICS

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#### INTRODUCTION

The linearly tapered slot antenna (LTSA) is a very useful antenna because of its simple construction, high gain and wide bandwidth (ref. 1). Previous experimental studies (refs. 2 and 3) emphasized the dependance of the beam width, directivity and gain on the flare length and angel of the LTSA. In addition we have previously demonstrated several novel techniques to feed a LTSA (ref. 4) and also studied the effect of a dielectric overlay on the LTSA beam width and gain (ref. 5). In all of the above investigations, the input impedance of the LTSA has been approximated to be the same as that of an equivalent biconical fin antenna (ref. 3). This approximation is valid only over a certain frequency band.

This paper demonstrates for the first time an accurate technique to determine the input impedance of a LTSA using a microwave wafer probe and a set of on-wafer Thru-Reflect-Line (TRL) slot line calibration standards. Experimental results are presented which show the variation of the input impedance as a function of the frequency with the semi-flare angle and flare length used as parameters.

# EXPERIMENTAL METHODOLOGY

The LTSA is fabricated on a 0.01 in. thick RT/chtroid 6010.5 ( $e_r = 10.5$ ). The layout of the LTSA is shown in figure 1. In this figure  $\theta$  and L represent the semi-flare angle and flare length respectively. The LTSA is excited through a short length of a slot line by a ground-signal microwave probe (Picoprobe Inc.) as shown in figure 2. The slot line minimizes the interaction between LTSA input terminals and the parasitic associated with the probe tips.

The reflection coefficient of the LTSA is de-embedded from the measured reflection coefficient (S<sub>11</sub>) at the input terminals of the slot line. The de-embedding is done with a HP 8510C Automatic Network Analyzer, a set of TRL on-wafer slot line calibration standards which is shown in figure 3 and the NIST de-embedding software (ref. 6). The software runs on a HP 9000 computer and controls the Network Analyzer.

#### **RESULTS AND DISCUSSIONS**

#### LTSA with Constant Length

The real and imaginary parts of the de-embedded LTSA input impedance  $Re(Z_{in})$  and  $Im(Z_{in})$  as a function of the frequency for  $\theta=5^\circ$  and L=1 in. are shown in figures 4(a) and (b) respectively. The plots of  $Z_{in}$  show a series of resonances over the frequency band. As the frequency varies from 2 to 26.5 GHz, the normalized length of the LTSA  $(L/\lambda_0)$  varies from 0.17  $\lambda_0$  to 2.24  $\lambda_0$ , where  $\lambda_0$  is the free space wavelength. The corresponding variation in the normalized width of the mouth of the LTSA  $(W/\lambda_0)$  is from 0.03  $\lambda_0$  to 0.4  $\lambda_0$ . In a LTSA at the lower end of the frequency band,  $W/\lambda_0$  is very small and hence the electric field intensity is large which results in a large wave

impedance. The large wave impediates in that smalls in a large Re(2) for the first resumnce made, typically about 2500 Ω. On the other hand at the upper end of the frequency band, the effective sperture is large and hence Re(Zin) is small, typically about 145  $\Omega$ . The minimum value of Rack. (Scenars between the resonances at the high end of the

frequency band) is about 40 Ω which is approximately half the value predicted in reference 2.

Measurements on several other LTALL with the mane L but with θ progressively increased from 5° up to 20° in steps of 2.5° show that at the lower end of the frequency band Re(Z<sub>k</sub>) decreases as θ increases. These results also support the above discussion. Figures S(a) and (b) show  $Re(Z_{\bullet})$  and  $Im(Z_{\bullet})$  respectively for  $\theta = 20^{\circ}$ . From figure 5(a), Re(Z<sub>in</sub>) is about 650 and 145 Ω at the low and the high end of the frequency band respectively. The minimum value of  $Re(Z_{in})$  is about 85  $\Omega$  which is about the same as predicted in reference 2.

## LTSA with Constant Sumi-Place Angle

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Figures 6(a) and (b) present the Re( $Z_{in}$ ) and Im( $Z_{in}$ ) respectively for  $\theta = 10^{\circ}$  and L = 3 in. In this case  $L/\lambda_0$  is about three times larger then the previous case and consequently there are about three times more resonances. For this LTSA, the Re(Z<sub>m</sub>) is initially large and is as high as 1300 Ω when L/A<sub>p</sub> = 1.15. Re(Z<sub>m</sub>) reduces as L/A<sub>p</sub> increases and is in the range of 55 to 130  $\Omega$  for L/ $\lambda_0$  > 5.6.

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CONCLUSIONS

An experimental technique to de-maille linear introduces of a TRSA from the measured reduction coefficient has been accounted by the linear improduces as dependent on the settle-fleet might end the least to decided it might of the LTSA least to the last to is small. However for an electrically large LEGA Ma(Z) is in the range of 55 to 130 Q. These results have potential applications in the design of broad band impedance matching networks for LTSAs.

### REFERENCES

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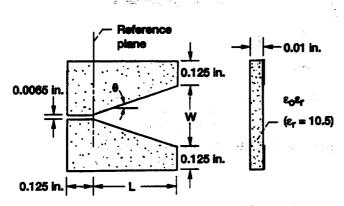


Figure 1.—Schematic of the LTSA.

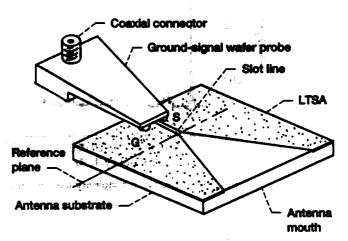


Figure 2.—Experimental set-up.

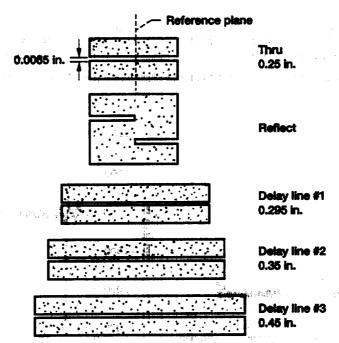


Figure 3.--TRL on-wafer slot line calibration standards.

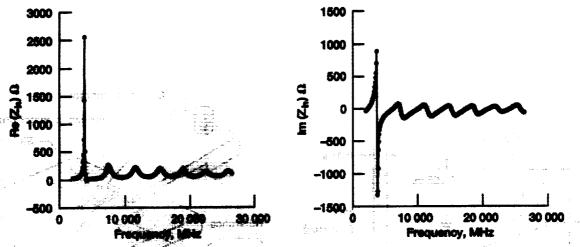


Figure 4.—Real and linegimary part of the input impedance ( $\theta = 6^{\circ}$ , W = 0.179 inch, L = 1 inch).

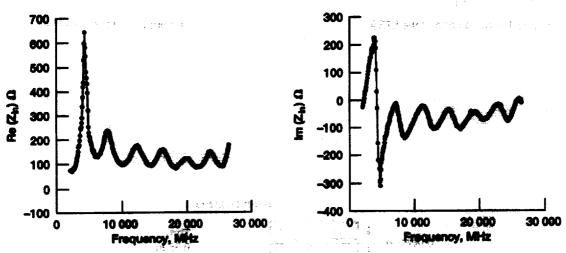


Figure 5.—Real and imaginary part of the input impedance ( $\theta = 20^{\circ}$ , W = 0.732 inch, L = 1 inch).

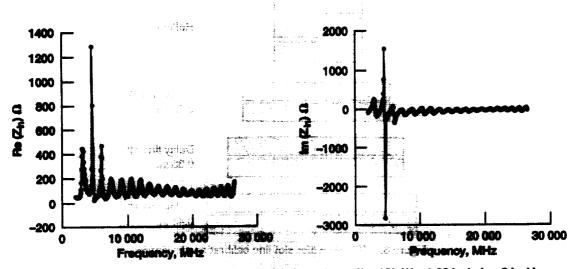


Figure 6.—Real and imaginary part of the input impedance ( $\theta = 10^{\circ}$ , W = 1.06 inch, L = 3 inch).

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